(12) UK Patent Application (19) GB (11) 2 251 002 (13) A

(43) Date of A publication 24.06.1992

(21) Application No 9126759.1

(22) Date of filing 17.12.1991

(30) Priority data
(31) 02402672 (32) 17.12.1990 (33) JP
03193160 01.08.1991
03193161 01.08.1991

(71) Applicants
**Ask Corporation**

**(Incorporated in Japan)**

**5-5, Tsurumi-chuo 2-chome, Tsurumi-ku, Yokohama-shi, Kanagawa-ken, Japan**

**Sanshin Thermal Insulation Company Limited**

**(Incorporated in Japan)**

**5-5 Tsurumi-chuo 2-chome, Tsurumi-ku, Yokohama-shi, Kanagawa-ken, Japan**

(72) Inventors
**Norihito Akiyama**
**Motonobu Abe**
**Shoichiro Irie**
**Yoshiomi Watanabe**
**Kazuo Sakamoto**

(74) Agent and/or Address for Service
**Marks & Clerk**
**57-60 Lincoln's Inn Fields, London, WC2A 3LS, United Kingdom**

(51) INT CL[5]
**D01B 1/24 1/50**

(52) UK CL (Edition K)
**D1N** N4B8B N4B8H N4B8J N4B8L
**D1R** RDE R101 R318 R455 R603 R611 R612 R614

(56) Documents cited
**GB 0857988 A** **GB 0572056 A** **GB 0410358 A**
**GB 0357574 A** **GB 0342672 A** **GB 0311342 A**
**US 4857145 A**

(58) Field of search
UK CL (Edition K) **D1N, D1R**
**Online databases : WPI**

(54) **Method of forming bamboo fibres and a resin moulding reinforced with bamboo fibre**

(57) A method of forming bamboo fibers comprises: a first step in which lengths of bamboo are crushed along the grain; and a second step in which the bamboo processed in the first step is fed by a conveying roller into a fibrillating device which includes a drum having many teeth and in which the bamboo is fibrillated. The bamboo may be further broken into fine fibers by a turbo-mill. Thus, the bamboo can be entirely fibrillated. A mixture of such bamboo fibers and a modified melamine resin is cured to form a useful hardened resin molding. The moulding may contain a filler. After one end portion of bamboo is fibrillated the rotation of conveying roller is reversed to draw the bamboo out and the bamboo is turned end for end before it is refed for fibrillating.

GB 2 251 002 A

# METHOD OF FORMING BAMBOO FIBERS AND A RESIN MOLDING REINFORCED WITH BAMBOO FIBER

## Field of the Invention

The present invention relates to a method of forming fibers of bamboo rapidly and efficiently, and also to a durable resin molding reinforced with such bamboo fiber.

## Description of the Related Art

Since bamboo is easy to be split along the grain (in the direction of growth), bamboo can easily be fibrillated by mechanical processes. There have been proposed various methods of fibrillating bamboo, such as a striking method and an explosive method.

For example, Japanese Patent Laid Open No. 63-7903 discloses a method of fibrillating bamboo, in which specified lengths of bamboo are put in a high pressure atmosphere for a certain period of time before they are abruptly taken out into a normal pressure atmosphere where they explode into fibers. However, this method, utilizing sudden air expansion to fibrillate bamboo, requires a batch process, and thus efficiency is not favorable. Also, the diameters and lengths of the produced bamboo fibers

substantially vary depending on the explosive conditions. Therefore, such a method is not very suitable for producing fibers for industrial raw material.

Resin moldings formed of a mixture of resin and a reinforcement of fibrillated or flaked wood are used in a wide range of products, such as particle board and fiber board. Plant materials other than wood are also used for reinforcement, and bamboo is one of such plant materials. Particularly these days, when conservation of forest resources is a crucial issue, bamboo is drawing much attention because of its rapid growth. Bamboo has favorable characteristics as a material, e.g. high strength and flexibility. However, those characteristics have not been fully utilized because, in the conventional art, bamboo is simply broken into fibers or flakes and then used in the same way as wood reinforcement.

## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of easily and economically forming bamboo fibers of a desired size.

It is another object of the present invention to provide a method of easily and economically forming bamboo fibers whose average diameter is less than 0.4mm.

It is still another object of the present invention to provide a resin molding reinforced with bamboo fiber which utilizes the favorable characteristics of bamboo and thus

provides good durability, i.e. an important characteristic of a resin molding.

According to the present invention, a method of forming bamboo fibers comprises: a first step where bamboo is broken in the growth direction; and a second step where the bamboo processed in the first step is sent through a feeding roller to a fibrillator having many teeth, by which the bamboo is fibrillated.

In the above method of forming bamboo fibers according to the present invention, after one end portion of the bamboo is fibrillated in the second step, there may be the following modification: the feeding roller is rotated in reverse to move the bamboo back; then the bamboo being turned the other way around; the second step is repeated to process the bamboo from the not-yet fibrillated end portion.

Another aspect of the present invention provides a method of forming bamboo fibers comprising a third step in which bamboo fibers provided by the above-mentioned first and second steps are formed into fine fibers by a turbo-mill.

Still another aspect of the present invention provides a hardened resin-molding molded with compression and heat from a mixture of 5 to 60 weight % of modified melamine resin and 40 to 95 weight % of the bamboo fibers obtained as above, such bamboo fibers having an average diameter of 0.01 to 2mm and an average length of 10 to 30mm.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described in detail hereinafter.

After being stripped of leaves, length of bamboo are cut into a certain size if necessary and then are fed into a crushing apparatus, splitting along the direction of growth. The crushing apparatus used in the first step of the method according to the present invention does not have to be a particular type, as long as it is a common type, such as rolling or a stamping mill. Since bamboo has a characteristic of being easily split along the grain, crushing apparatus as above can split the bamboo easily along the grain.

In a method according to the present invention, it is not necessary to severely control the water content of bamboo to be processed. Bamboo stems must be cut longer than the desired length of the fibers.

The length of bamboo split in the first step are conveyed by a conveying rollers to an opening machine including a rotary drum having many teeth, by which the bamboo is fibrillated. Such an opening machine used in the second step may be a pickering machine. The length and diameter of bamboo fibers can be varied by adjusting the size or number of teenth, or the rotational speed of the pickering machine. Thus, bamboo fibers of desired length and diameter can be easily formed.

However, in the above described method, occasionally rear end portions of split bamboo are not sufficiently

fibrillated but become bundled up. In such a case, the following method may be performed: after a portion of split bamboo is fibrillated, rotation of the convey rollers are reversed to move the bamboo back out, and then the bamboo is turned end for end before it is again fed into the pickering machine. In this method, the entire bamboo can be fibrillated.

The bamboo fibers obtained as described above have an average diameter of roughly 0.4 to 1.5mm. However, finer fibers may be required in some cases.

Although the diameter of fibers can be adjusted by changing the size or number of teeth, or the rotational speed of the pickering machine, the range of such adjustment is not wide enough for forming fine fibers whose average diameter is less than 0.4mm.

Also, though repeated fibrillation by the pickering machine will produce finer fibers, such a process will also produce more dust; in other words, the yield will decrease. Thus, such a process is not very efficient.

In order to provide fine fibers, a turbo-mill may be employed as a third step to refine coarse bamboo fibers obtained in the second step. Before being refined by the turbo-mill, coarse bamboo fibers may be cut into a specific length. Naturally, such a specific length must be greater than the desired length of refined fibers.

The turbo-mill mentioned above can be the one used for powdering or grinding a variety of materials, i.e. both

organic and inorganic materials, or even for opening asbestos. However, if a turbo-mill is used to finely fibrillate bamboo immediately after the first step, such a process will require a long time and result in a poor yield. Thus, such a process is not efficient for forming fine fibers.

The three serial steps described above will easily and efficiently provide fine bamboo fibers having an average diameter less than 0.4mm.

The bamboo fibers thus obtained have a wide range of uses, such as for building materials, as filler or reinforcement, and as feed for livestock. The bamboo fibers may be added as a reinforcement to cement mortar, thus providing a structural part of cement board of an architectural structure. Also, the fibers may be mixed with a hardening resin, forming a value added reinforced hardened resin-molding.

Experiments on the bamboo fibers according to the present invention show that bamboo fibers having an average diameter or 0.01 to 2mm and an average length of 10 to 30mm are preferable as reinforcing fibers for a resin molding. A resin to be used for the hardened resin molding reinforced with the bamboo fibers is preferably a modified melamine resin. The modified melamine resin is melamine-formaldehyde condensate modified with phenol, such as SM-510, SM-607, SM-800 and SM-850 manufactured by Showa High Polymer Co.

The mixing ratio of the bamboo fibers and the modified melamine resin is 40 to 95% by weight bamboo fibers and 5 to 60% by weight resin, and preferably 80 to 90% bamboo fibers and 10 to 20% resin. Hardening of the mixture may be carried out at an elevated temperature such as 120 - 180°C. A hardening catalyst such as a high grade amine-hydrochloride may also be used if required.

A hardened resin molding reinforced with bamboo fiber may contain a filler as long as such a filler does not obstruct the molding process or degrade the property of the product. Such a filler may be any one of the following: wood fibers; pigments; powder of inorganic substances such as silica powder, calcium carbonate powder and calcium silicates powder, e.g. wollastonite, xonotlite and tobermorite. The total weight of added filler is preferably 30 parts or less to 100 parts of the total weight of the bamboo fibers and resin. The added wood fiber is preferably 20 parts or less to 100 parts of the bamboo fibers.

A mixture of the bamboo fibers, a resin and other materials as mentioned above is molded under compression and heat into a hardened resin molding reinforced with bamboo fiber according to the present invention.

EXAMPLES

Methods of the present invention are illustrated with reference to the following examples, but the invention is not intended to be limited only to these following examples.

EXAMPLE 1

(the first step in which lengths of bamboo are roughly crushed along the grain by a rolling mill):

the first step by rolling

material of roller: carbon steel (S45C)

diameter of roller: 150mm,

length of roller (effective length) : 500mm

Lengths of bamboo were stripped of leaves and cut into about 1m lengths. Such lengths of bamboo were processed by the rolling mill described above under a pressure of 25 $kg/cm^2$, at a conveying speed of 15m/min and a processing rate of 180kg/h.

The bamboo was crushed along the grain into long pieces. Each piece had many cracks along the grain with intervals of about 1.0 to 3mm.

(the second step in which bamboo is fibrillated by a pickering machine):

The bamboo roughly crushed in the above mentioned first step was fed by way of conveying rollers into a pickering machine having a 500mm diameter drum and an effective length of 900mm with many teeth and which was rotated at 1000 rpm, to thus fibrillate the bamboo.

By the process described above, bamboo fibers having an average length of 25cm and an average diameter of 0.5mm were obtained. The dry-weight ratio of the yielded fibers to the

original bamboo was 75 to 100. However, about 5% of the bamboo fibers were still in bundles at end portions.

Therefore, after one end portion of bamboo was fibrillated by the pickering machine, the conveying roller was reversed to draw the bamboo out of the pickering machine, the bamboo was then turned the other way around and fed into the drum of the pickering machine with the not-yet fibrillated end portion being ahead. In this manner, the bamboo was entirely fibrillated, and no bundle portions remained.

(the third step in which bamboo is finely fibrillated by a turbo-mill)

The coarse bamboo fibers obtained through the first and second steps were cut into lengths of 40mm or less. Using a T-400 TURBOMILL manufactured by Turbo Kogyo Co., the cut coarse fibers were refined by rotating the turbomill at about 4000 r.p.m. into bamboo fibers having an average length of 30mm and an average diameter of 0.07mm. The dry weight ratio of the yielded fine fibers to the original bamboo was 70 to 100.

EXAMPLE 2

(forming of hardened resin-molding reinforced with bamboo fibers)

The bamboo fibers obtained through the first to third steps were mixed with a resin and a filler as described in Table 1. The mixtures were molded under a pressure of 5kg/

$cm^2$ at 150°C for 3 hours, and after being cooled, the resin moldings reinforced with bamboo fiber were removed from the molds. The properties of the moldings (specimens) were measured and the results are shown in Table 2.

TABLE 1 (mixture)

| | spec. 1 | spec. 2 | comp. 1 | comp. 2 |
|---|---|---|---|---|
| Bamboo Fibers | 50 | 42 | 30 | 50 |
| Resin | 50 | 50 | 70 | 50 |
| Filler (wollastonite) | | 8 | | |

NOTE: "spec." and "comp." refer to specimen and comparison specimen respectively.

All values are in weight percent.

The resin used for spec. 1, spec. 2 and comp. 1 was a modified melamine resin SM-510 grade made by showa High Polymer Co., and the resin used for comp. 2 is a styrene-acryl resin AM-2300 made Showa High Polymer Co.

TABLE 2 (properties)

| | spec. 1 | spec. 2 | comp. 1 | comp. 2 |
|---|---|---|---|---|
| Specific Gravity(*1) | 0.66 | 0.67 | 0.76 | 0.68 |
| Flexural Strength ($kg/cm^2$) (*1) | 86 | 83 | 53 | 67 |
| Durability (*2) | O | O | Δ | X |

NOTE: (*1) were measured according to JIS A 5908.

(*2): Specimens were soaked in boiling water for 2 hours and then cooled in water at 20°C for 1 hour. This

procedure was repeated three times before the exteriors thereof were observed. In the table, O indicates little change observed in the exterior, Δ indicates some change observed, and X indicates great change observed.

CLAIMS

1. A method of forming bamboo fibers, comprising:

a first step in which lengths of bamboo are crushed in the direction of growth or along the grain;

and a second step in which the bamboo processed in the first step is fed by a conveying roller into a fibrillating device which includes a drum having many teeth, and the bamboo is fibrillated by said device.

2. A method of forming bamboo fibers according to claim 1, wherein after one end portion of the bamboo is fibrillated in said second step, the conveying roller is reversed to draw the bamboo out, and the bamboo is then turned the other way around and re-fed so as to fibrillate the not-yet fibrillated end portion of the bamboo.

3. A method of forming bamboo fibers according to claim 1 or 2, further comprising:

a third step in which the bamboo processed in the second step is refined to fine fibers by a turbo-mill.

4. A hardened resin molding reinforced with bamboo fiber obtained by a method according to any of claims 1 to 3, which is molded under compression and heat from a mixture of 5 to 60 weight % of a modified melamine resin and 40 to 95 weight % of the bamboo fibers having an average diameter of 0.01 to 2mm and an average length of 10 to 30mm.

5. A hardened resin molding reinforced with bamboo fiber according to claim 4, wherein the average diameter of said bamboo fibers is 0.4mm or less.

6. A hardened resin molding reinforced with bamboo fiber according to claim 4 or 5, wherein said mixture contains by weight 80 to 90% bamboo fibers and 10 to 20% resin.

7. A hardened resin molding reinforced with bamboo fiber according to any one of claims 4, 5 and 6, wherein less than 30 weight parts of a filer other than bamboo fibers is added to 100 weight parts of total weight of the bamboo fibers and resin.

8. A method of forming bamboo fibres, the method being substantially as hereinbefore described.

9. A hardened resin moulding substantially as hereinbefore described.

-14-

**Patents Act 1977**
**Examiner's report to the Comptroller under ction 17 (The Search Report)**

Application number

9126759.1

**Relevant Technical fields**

(i) UK Cl (Edition K ) D1N;D1R(SELECTIVELY)

(ii) Int Cl (Edition )

Search Examiner

M SIDDIQUE

**Databases** (see over)

(i) UK Patent Office

(ii)
ONLINE DATABASE: WPI

Date of Search

4 FEBRUARY 1992

Documents considered relevant following a search in respect of claims ALL

| Category (see over) | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
| Y | GB 857988 (SCOTT PAPER) page 2 lines 28-29, 54 etc | 4 at least |
| Y | GB 572056 (FRISCHE) splitting longitudinally followed by crushing | 1 at least |
| Y | GB 410358 (GENNARO) knife rollers 4 followed by crushing rollers/drums 5 | 1 at least |
| Y | GB 357574 (KOIRANSKY) cutting longitudinally and crushing by toothed rolls | 1 at least |
| Y | GB 342672 (DRON) splitting and crushing by toothed roller | 1 at least |
| Y | GB 311342 (NAAMLOOZE) splitting followed by crushing | 1 at least |
| Y | US 4857145 (VILLAVICENCIO) column 1 lines 51-70; column 2 lines 40-41; column 3 lines 22-35 etc | 1 at least |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
| | | |

**Categories of documents**

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1992 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.